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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
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08/995,108 12/19/97 DING

P AM-1776

EXAMINER

IM62/0417

PATENT COUNSEL
APPLIED MATERIWLS INC
PO BOX 450-A
SANTA CLARA CA 95052

MERCADO, J

ART UNIT

PAPER NUMBER

1745

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04/17/00

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

File Copy

Office Action SummaryApplication No.
08/995,108Applicant(s)
Ding et al.Examiner
Julian A MercadoGroup Art Unit
1745☒ Responsive to communication(s) filed on Feb 1, 2000☒ This action is **FINAL**.☐ Since this application is in condition for allowance except for formal matters, **prosecution as to the merits is closed** in accordance with the practice under *Ex parte Quayle* 1935 C.D. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire 3 month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claim☒ Claim(s) 8-27 is/are pending in the application

Of the above, claim(s) _____ is/are withdrawn from consideration

☐ Claim(s) _____ is/are allowed.☒ Claim(s) 8-27 is/are rejected.☐ Claim(s) _____ is/are objected to.☐ Claims _____ are subject to restriction or election requirement.**Application Papers**☐ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.☐ The drawing(s) filed on _____ is/are objected to by the Examiner.☐ The proposed drawing correction, filed on _____ is ☐ approved ☐ disapproved.☐ The specification is objected to by the Examiner.☐ The oath or declaration is objected to by the Examiner.**Priority under 35 U.S.C. § 119**☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).☐ All ☐ Some* ☒ None of the CERTIFIED copies of the priority documents have been☐ received.☐ received in Application No. (Series Code/Serial Number) _____☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: _____

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).**Attachment(s)**☐ Notice of References Cited, PTO-892☐ Information Disclosure Statement(s), PTO-1449, Paper No(s). _____☐ Interview Summary, PTO-413☐ Notice of Draftsperson's Patent Drawing Review, PTO-948☐ Notice of Informal Patent Application, PTO-152

— SEE OFFICE ACTION ON THE FOLLOWING PAGES —

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DETAILED ACTION

1. This Office Action is responsive to Applicant's Amendment filed February 1, 2000.

The rejection of claims 21-27 under 35 U.S.C. 112, first paragraph has been dropped in light of Applicant's amendment.

The rejection of claims 21-27 under 35 U.S.C. 112, second paragraph has been dropped in light of Applicant's amendment.

The rejection of claims 8-11, 14, 15 and 17 under 35 U.S.C. 102(b) based on Colgan *et al* (U.S. Pat. 5,281,485) and the rejection of claims 12, 13, and 16 under 35 U.S.C. 103(a) as being unpatentable over Colgan *et al* in view of either Landers *et al*, Gelatos *et al* or Hoshino, have been dropped in light of Applicant's amendment.

The rejection of claims 8-17 under 35 U.S.C. 103(a) as being unpatentable over Hindman *et al* (U.S. Pat. 5,240,880) in view of either Landers *et al* or Hoshino has been dropped in favor of the ground of rejection(s) maintained below.

Claim Rejections - 35 USC § 103

2. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

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3. Claims 8-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gelatos *et al* (U.S. Pat. 5,391,517) in view of Landers *et al* (U.S. pat. 5,676,587), all of record and for the reasons of record.

The previous Office Action had set forth Gelatos in view of Landers as a *prima facie* case to render obvious Applicant's invention. In addition, Landers in view of Gelatos was also set forth under the same ground of rejection. The latter combination of Landers in view of Gelatos has now been dropped in favor of Gelatos in view of Landers, for the reasons set forth in the previous Office Action and reiterated below.

The ground of rejection based on Gelatos in view of Landers here follows. Gelatos was relied upon to teach a first layer of TiN_x followed by a second layer of Ti. The first and second layers comprise a barrier layer for a subsequently deposited layer of copper.

Gelatos does not explicitly teach employing Ta and TaN as the barrier layer. However, Gelatos clearly suggests that Ta can be employed as part of the barrier layer. (Col. 3 line 56 *et seq*) It is submitted that based on this teaching by Gelatos alone, the skilled artisan would find obvious to substitute, correspondingly, tantalum for titanium and tantalum nitride for titanium nitride. As further evidence that Ti/TiN and Ta/TaN are obvious variants over one another, Landers is relied upon to teach that both Ti/TiN and Ta/TaN layers are well known as barrier layers and are art-recognized equivalents in regards to functioning as an underlying refractory metal layer for a subsequent deposition of copper.

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Applicant submits that Gelatos in view of Landers has no suggestion that the copper layer has a high $\langle 111 \rangle$ crystal orientation. However, it is noted that Gelatos in view of Landers was not relied upon as a basis for rejection of this limitation. In response to Applicant's argument that Gelatos teaches away from the claimed invention which requires a substrate temperature of less than 500 °C, Gelatos is cited to teach a substrate temperature of less than 500 °C such as found within the disclosed range of 400 °C to 500 °C. (Col. 5 line 39)

4. Claims 8-17 and 21-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hoshino (U.S. Pat. 4,985,750) in view of Landers, all of record and for the reasons of record.

Hoshino in view of Landers has been discussed extensively in the previous Office Action. A reiteration of the ground of rejection based on Hoshino in view of Landers here follows. Hoshino teaches deposition of a first layer [20], followed by the deposition of a second layer [22] of Ta layer having a thickness in the range of 500 to 3000 Å, followed by the deposition of a conductive layer of copper [24]. The copper (Cu) layer is annealed at a temperature of less than 500 °C.

Hoshino does not explicitly teach the first layer to be TaN. However, Landers as discussed above teaches that a Ta/TaN combination for a barrier layer is well-known and desired as the underlying barrier layer for a subsequent copper metallization overlay. A modification of Hoshino's invention would therefore result in the first layer being a TaN layer, since the second layer is disclosed to be Ta.

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Applicant appears to argue that Hoshino's teaching of depositing copper over the barrier layer will result in copper being deposited over the first layer of TaN. However, it is clear from Figure 2 that the first layer [20], second layer [22] and copper layer [24] are deposited in this exact order from the frame of reference of bottom layer to top layer. The copper layer [24] is clearly deposited to overlay the Ta layer [22]. Applicant also submits that Hoshino does indeed teach the deposition of copper over a second layer of Ta layer, but does not explicitly teach a first layer of TaN. Applicant's latter argument is exactly what the rejection based on Hoshino in view of Landers was intended to render obvious at least to one of ordinary skill in the art. A modification of the first layer in Hoshino's invention by employing its corresponding nitride would have been obvious to the skilled artisan because a Ta/TaN barrier layer combination is well-known and desired as an effective barrier layer for copper metallization.

5. Claims 18-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gelatos *et al* in combination with Landers *et al* as applied to claims 8-17 above, and further in view of Ngan (U.S. Pat. 5,707,498).

6. Claims 18-20 and 27 are also rejected under 35 U.S.C. 103(a) as being unpatentable over Hoshino in view of Landers as applied to claims 8-17 above, and further in view of Ngan, all of record and for the reasons of record.

The teachings of Gelatos, Hoshino and Landers are discussed above.

Gelatos, Landers and Hoshino do not explicitly teach at least a portion of the Ta layer and TaN_x layer deposited using ion-deposition sputtering. Applicant submits that the above cited

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prior art combination when further in view of Ngan does not teach or suggest ion deposition sputtering as a method for deposition of the instant metal-comprising layers. However, as discussed in the previous Office Action, Ngan teaches that in the manufacture of semiconductor devices, ion-deposition sputtering is preferred over traditional sputtering in order to have uniform step coverage and filling of contact hole vias. Note that Ngan uses ion-deposition sputtering to deposit an elemental metal and its corresponding nitride as the metal-comprising layers. At the time the invention was made, it would have been obvious to one of ordinary skill in the art to further modify either Gelatos or Hoshino's invention by employing ion-deposition sputtering, because Ngan teaches that ion-deposition sputtering improves deposition in semiconductor manufacturing.

Conclusion

7. The prior art relied upon in this Office Action will not be provided since it is the same prior art made of record in the previous Office Action.

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period


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will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Julian A. Mercado whose telephone number is (703) 305-0511 . The examiner can normally be reached on Monday through Thursday from 8:30 AM to 6:00 PM. The examiner can also be reached on alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Maria Nuzzolillo, can be reached on (703) 305-3776. The official fax phone number for the organization where this application or proceeding is assigned is (703) 305-3599. The unofficial fax number is (703) 306-3429.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0661.


jam/April 12, 2000

Maria Nuzzolillo
Supervisory Patent Examiner
Technology Center 1700

